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SEDIMENT FEASIBILITY STUDY
TECHNOLOGY IDENTIFICATION AND SCREENING
TECHNICAL MEMORANDUM 1
PACIFIC SOUND RESOURCES
MARINE SEDIMENTS UNIT
SEATTLE, WASHINGTON

Prepared for

U.S. Environmental Protection Agency
Region X
1200 Sixth Avenue
Seattle, Washington 98101

Contract No. 68-W9-0046
Work Assignment No. 46-37-0M2L
Work Order No. 4000-031-001-6100-02
Document Control No. 4000-031-001-AABS

23 March 1998

Prepared by

Roy F. Weston, Inc.
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ARCS QUALITY ASSURANCE CONCURRENCE

Sediment Feasibility Study
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Technical Memorandum 1

Project Name:	Pacific Sound Resources Marine Sediments Unit Seattle, Washington
Contract Number:	68-W9-0046
Work Assignment Number:	46-37-0M2L
Responsible Organization:	Roy F. Weston, Inc. 700 Fifth Avenue, Suite 5700 Seattle, Washington 98104

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MARINE SEDIMENTS UNIT

1. INTRODUCTION

As part of the Feasibility Study (FS) for the Marine Sediments Unit of the Pacific Sound Resources (PSR) Superfund site, Roy F. Weston, Inc. (WESTON®) will, prior to publication of the FS report, prepare three technical memoranda to develop key components of the cleanup options for the site. These memoranda will be used to develop a consensus internally within the U.S. Environmental Protection Agency (EPA) and with other reviewing agencies regarding the most acceptable approach to remediating the Marine Sediments Unit (MSU).

The first memorandum will consist of identification and screening of global (sitewide) technologies to determine which should be included in alternatives to be evaluated in the feasibility study. The second memorandum will propose site-wide cleanup alternatives based on the technologies retained from the recommendations made in the first technical memorandum. The third memorandum will provide a detailed evaluation of the cleanup alternatives proposed in the second memorandum.

Upon completion of these three memoranda, a FS report will be assembled that includes the results of these memoranda as modified by agency comments, in addition to other pertinent site information.

This memorandum provides an initial identification and screening of sediment remedial technologies for the PSR MSU that could be used to remediate the contaminated sediment. This work is being performed to determine which technologies should be incorporated into the site-wide cleanup alternatives.

2. BACKGROUND

The sediments within the PSR MSU are contaminated with a number of organic chemicals that have been released from the upland facility. Polycyclic aromatic hydrocarbons (PAHs) represent the main contaminants of concern, although polychlorinated biphenyls (PCBs) and dioxins are also present in the sediment. A detailed evaluation of the nature and extent of contamination in the MSU is provided as part of the draft Remedial Investigation (RI) report (WESTON 1998). As a follow on to the RI, a feasibility study is being conducted, which develops various alternatives, evaluates them with respect to protectiveness, cost, technical feasibility and other Comprehensive Environmental Response, Compensation and Liability Act

(CERCLA; Superfund) criteria to allow the EPA to select the optimum remedy for site cleanup.

EPA guidance for FS preparation (EPA/540/G-89/004 "Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA") suggests developing and screening an initial set of technologies, such that the most reasonable technologies are carried through the FS for subsequent detailed alternative development and evaluation.

This memorandum screens the applicable technologies based on three (effectiveness, implementability, and cost) of the nine CERCLA criteria to eliminate impracticable technologies from further evaluation in the FS.

3. IDENTIFICATION AND SCREENING OF TECHNOLOGIES

3.1 Identification of Technologies

Identification of applicable technologies requires developing remedial action objectives (RAOs), determining general response actions that could be used to meet those objectives, followed by identification of technology types that fall within the general response action categories.

3.1.1 Remedial Action Objectives

The RAOs are based on state standards, and human health and ecological impacts as discussed in the Risk Assessment Technical Memorandum (WESTON 1997).

RAOs for the PSR MSU are:

- Prevent exposure of fish and/or shellfish to contaminated media such that cancer risks to subsistence fishers consuming seafood collected from the site are reduced to 1×10^{-4} to 1×10^{-6}.

- Prevent marine organisms from contacting sediment that exceeds Washington State Sediment Management Standards to reduce unacceptable impacts to the benthic community.

3.1.2 General Response Actions

General response actions are types of responses that achieve the RAOs listed above and consist of the following:

Containment

This general response action consists of confining or isolating the contaminants in-place (*in situ*) to prevent exposure to the receptors. For sediment, containment is limited to placement of a cap over the contaminated materials to prevent receptor dermal exposure or ingestion.

Removal

Removal consists of excavating the contaminated material from the environment such that levels of contaminants in the remaining sediment are representative of levels that do not constitute significant exposure to receptors. Removal requires either (1) a location to dispose of the excavated material that achieves confinement or isolation of the material from potential receptors or (2) a treatment process to destroy the contaminants or render them nontoxic.

Disposal

The disposal general response action is a component of removal and consists of disposing the excavated sediment at a location designed to restrict contaminant mobility to prevent further contact with people or ecological receptors. Disposal may occur with or without prior treatment. Typically, the sediments would be placed into an constructed disposal site where they would be capped to achieve isolation and then periodically monitored to ensure isolation from potential receptors.

Treatment

Treatment is a potential component of a removal action and consists of altering the sediment using chemical, physical, or biological processes to render the contaminants nontoxic. Treatment technologies are designed to destroy the contaminants; stabilize them such that they are not mobile and cannot enter into living organisms; or change the form of the chemical contaminant such that it is no longer toxic or has reduced toxicity.

Treatment can be performed in place (*in situ*) or following removal to another location (*ex situ*). *Ex situ* treatment requires transport to an upland location where sediments can be processed through a treatment facility. There are currently no effective *in situ* treatment processes for sediment covering a large area or that are subjected to significant flushing.

No Action/Institutional Controls

No Action and Institutional Controls do not meet RAOs and are not evaluated in this technical memorandum; however, the No Action alternative will be retained as baseline alternative to compare all other alternatives to. Institutional Controls will be included in specific alternatives where needed to preserve the effectiveness of the remedial action.

3.1.3 Technology Types

This section discusses types of technologies that fall within the sediment general response actions listed above. A brief description of the technology is provided.

3.1.3.1 Containment Technology Types

The Containment General Response Action for sediment has essentially one applicable technology—capping. Capping consists of placing a relatively thick layer (approximately 3 feet thick) of clean sediment or other material over the impacted sediment. This layer of clean fill prevents or reduces contaminant migration as well as provides clean habitat to promote re-establishment of a health benthic community. Capping material is generally the same type of material that is present, except it contains no harmful contaminants. Capping material is usually obtained from other dredging projects in the local region.

Other types of capping techniques such as placing an impermeable cap of clay or geosynthetic materials have not been included since they cannot be effectively constructed under water.

3.1.3.2 Removal Technology Types

Removals may be completed by excavation or dredging. Excavations are typically done for shoreline or shallow nearshore removals using a land-based or barge-mounted backhoe. Use of a backhoe for sediment removal generally has limited application because of issues related to production and depth capabilities. Dredging is the main removal technologies for sediment. Two types of dredging are possible —mechanical or hydraulic.

Mechanical dredging typically uses a clamshell attached to the end of a crane. The clamshell is lowered through the water via a cable and into the sediment. Lifting the clamshell using the operating cable closes the clamshell, enclosing the contaminated sediment. The sediment is then brought to the surface where it is placed onto a barge. Several types of clamshells are available that have been designed to minimize sediment loss during dredging, however no design currently exists that eliminates water column impacts.

Hydraulic dredging consists of removing the sediment through use of a pump-and-dredge head. The suction head of the pipe is lowered into the sediment where the sediment is pulled into the pipe and then pumped via pipeline to a disposal facility. A cutterhead can be attached to the end of the dredge head to facilitate the breakup of hard sediments so that it can be suctioned.

3.1.3.2.1 Disposal Technology Types

Disposal options for contaminated sediment consist of nearshore disposal, confined aquatic disposal (CAD) or upland disposal.

Nearshore disposal involves constructing a retaining structure or berm adjacent to an existing shoreline and filling with contaminated sediment. Existing shoreline, piers, or other structures can form one or more sides of the retaining structure. The retaining structures can be constructed of riprap, sheet pile, sediment, or other types of materials. Retaining structures made of natural sediment or other earthen materials require the sides to be sloped for stability. Riprap has the most stability at the steepest slope (1.5H:1V); thus, its use requires less material to construct a berm. However, riprap used by itself only provides limited contaminant confinement. Sand is a better material for contaminant confinement but requires a much shallower slope to achieve stability, and therefore requires more material to construct a berm. When the nearshore area is filled with sediment, its surface is typically equal in height to the surrounding land. Nearshore disposal sites result in filling intertidal and subtidal areas and create upland areas that can be used for land-based needs. Depending on site-specific conditions, creation of aquatic habitat can be included in the design of a nearshore facility.

Disposal at a CAD site consists of placing contaminated sediment at a central subtidal location and capping it with clean material. Contaminated sediment is consolidated into a subsurface pile several times the thickness of the original contaminated material over less surface area. In some instances, a depression may be dredged in the sediment at the disposal site prior to filling to increase the capacity of the CAD without increasing its footprint. Some CAD sites with greater bottom slopes require construction of a subtidal retaining berm to hold the sediment in place. The subtidal berm may be constructed of clean fill or larger material such as quarry spalls. A retaining berm is generally used where there are no subtidal areas with a constant, low-level slope. Aquatic habitats are not lost, but short-term impacts to benthic communities occur during the construction and filling of the CAD. CAD site design can include habitat enhancement as design component, depending on site conditions.

Upland disposal is essentially a landfilling operation and consists of constructing an upland landfill to place contaminated sediments. However, sediments contain a greater degree of water than most landfilled materials and therefore may require a liner, cover, leak detection and monitoring to ensure the contaminants remain in place. Upland disposal could also consist of disposing the sediments at an existing landfill permitted to accept the types and concentrations of contaminants that exist in PSR MSU. If the concentrations of contaminants are below Washington State Department of Ecology Model Toxics Control Act (MTCA) requirements, the sediment could be used as unregulated fill.

3.1.3.2.2 Treatment Technology Types

Treatment technologies that could be used to treat the contaminated sediments consist of thermal treatment processes, solvent extraction processes, and soil washing.

Thermal treatment technologies such as incineration or thermal desorption subject the sediment to high temperatures (typically up to 900 degrees Fahrenheit for desorption and

3,000 degrees Fahrenheit for incineration). In the incinerator, the organics are vaporized and combusted in the primary combustion chamber. A secondary combustion chamber is used to treat any unburned organic gases. In the thermal desorber, the organics are vaporized, but not necessarily combusted. The organic vapors can be either released into the environment depending upon their concentration or can be recondensed to remove them from the vapor stream depending upon the type of desorber.

Solvent extraction processes remove organic contaminants by dissolving them off the sediment and into the solvent. Typical solvents include liquid propane, butane or triethylamine. The solvent containing the organic contaminant is then processed to separate the organics from the solvent. The result is a concentrated liquid stream containing the organic contaminants and a clean solvent stream that is recycled back into the process. Solvent extraction processes are affected by the amount of water present in the matrix to be treated; therefore, solvent extraction of sediment will likely require a dewatering step prior to treatment.

Soil washing technology consists of taking the contaminated sediment and washing it with water-based surfactants to remove the contaminants from the soil. In addition, soil washing technologies also separate out the fine-grained material (which typically contains the majority of the contaminants) from the coarser-grained materials. Because of the size separation, the coarser-grained materials, which can make up the majority of the soil, can have contaminant concentrations that are below cleanup levels and thus allow other disposal options for a large fraction of the sediment. The wash water containing the contaminants is treated to settle out the fine particles or remove the dissolved contaminants and then recycled back into the process.

3.2 Technology Screening

This section evaluates the above-listed technologies to determine which should be retained for alternative development and which should be eliminated. Technologies can be eliminated based on technical difficulties, administrative concerns, or excessive costs.

3.2.1 Cleanup Criteria

The above technologies are evaluated and screened with respect to achieving two potential sets of cleanup criteria—cleanup screening levels (CSL) and sediment quality standards (SQS). Approximately 967,000 cubic yards of sediment over 94 acres exceeds SQS standards. Approximately 471,000 cubic yards of sediment over 47 acres exceeds CSL standards.

3.2.2 Containment Technology Screening

This technology is effective in isolating the contaminants from human exposure and marine organisms as long as the cover is adequately thick. Based on sediment grain size and bathymetry, the PSR sediment does not appear to exist in an erosional area. Therefore, a layer of clean sediment placed over the contaminated sediment should persist and provide long-term isolation of the contaminants. However, intrusive actions may impact the effectiveness of the cover. For instance, anchoring large ships in this area can disturb the sediment to depths of 4 to 5 feet. In this case, it is possible that a small portion of the cap could be impacted. Institutional controls may be necessary to protect the cap. Long-term monitoring will also be a component of capping to ensure its effectiveness.

Placing a layer of clean sediment over contaminated sediment is technically implementable at this site. Site depths of 200 feet or more that exist in the MSU do not present an insurmountable problem or result in excessive costs. However, the areas of the MSU that exist at depths of approximately -250 feet MLLW are likely at the limit of effective cap placement. Beyond these depths, more effort is required in accurately placing the material and monitoring its thickness.

This technology would protect human health and the environment and is technically implementable. This technology is retained for further evaluation.

3.2.3 Removal Technology Screening

Use of land-based or barge-mounted excavators to remove contaminated sediment is potentially feasible for removals along the shoreline; however, it is technically difficult to implement at depths of 40 feet or deeper. Although there are excavators that can reach to depths of 90 feet, this equipment is very limited. In addition, excavators generally do not remove large quantities of material quickly as is needed for sediment remediation. Use of excavator bucket types would also result in high material losses and resuspension rates. Because of equipment limitations, high resuspension rates and slow removal rates, use of excavators for removal of contaminated sediment is not retained for further evaluation.

Mechanical dredging is usually performed using a clamshell bucket attached to the end of a crane. Clamshell dredge buckets can range in capacity from one to fifty cubic yards. Material densities of approximately 60 percent of the *in situ* density can be obtained. Because the clamshell is crane operated, it has a greater depth capacity than other dredges. Depth capabilities are limited primarily by the quantity of cable on the spool. Clamshell dredges operating locally can achieve depths of 150 to 200 feet. Depth capabilities for clamshell dredges in other areas of the country are not expected to be significantly different than locally. Clamshell dredges can attain dredging rates of up to 3500 cubic yards per 24-hour day. Clamshell dredges may have moderate to high resuspension rates and sediment losses of 1 percent can occur. Depending upon the level of sediment contamination, clamshell dredging can be effective.

Because of the depth capabilities and effectiveness in less contaminated sediment (where resuspension is less of a concern), clamshell dredging is retained for further evaluation.

Hydraulic dredging has low resuspension rates and high sediment removal rates. However, large quantities of water are typically entrained with the sediment (up to nine times the sediment volume). Hydraulic dredges available in Puget Sound typically have depth operating ranges of up to 60 to 90 feet. The dredges are usually attached to a mechanical arm that controls lowering and placement of the dredge head. The dredged sediment can be pumped over long distances (up to one mile) to a disposal area. A new dredge design (Eddie Pump™) uses a high energy vortex to dislodge the sediment that is then pumped via a pipeline to the disposal site. This type of dredge can remove and transfer sediment containing up to 50 to 60 percent solids as compared to 5 to 10 percent solids with normal type hydraulic dredges. The Eddie Pump™ can be equipped to dredge at depths of 150 to 200 feet since it is attached to the end of a cable and controlled by a crane. The Eddie Pump™ dredge is not available locally but can be easily shipped to this region.

Hydraulic dredging has the capability to remove large quantities of sediment quickly with little resuspension and materials handling. For these reasons, hydraulic dredging is retained for further evaluation.

Sediment exceeding CSLs and SQS standards is estimated at 471,000 and 967,000 cubic yards, respectively. Nearly all sediment volume (90 percent) exceeding CSL standards is located at depths of less than 200 feet. Approximately 85 percent of the sediment volume exceeding SQS standards is present at depths less than 200 feet. Approximately 15 percent and 25 percent of the area exceeding CSL and SQS standards, respectively, exists at depths greater than 200 feet.

Dredging all sediment that exceeds SQS standards would be technically difficult because removal would approach the practical depth limitations for dredging (200 to 250 feet). In addition, there are no local disposal sites that could easily handle 967,000 cubic yards of dredged material. Dredging all sediment to SQS standards and disposing of it in a nearshore site (assuming availability and capacity) is roughly estimated to cost over $60 million. Other less-expensive technologies (such as capping) would provide the same level of protectiveness at less cost. For these reasons, dredging all sediment that exceeds SQS standards is not considered further. However, dredging the areas exceeding CSL criteria is being retained because the volume (and therefore, cost) is about half the cost of removing sediments exceeding SQS and the majority of the volume is within dredging limits. In addition, it is likely that a disposal facility that has sufficient capacity to address the CSL exceedance volume can be developed.

3.2.4 Disposal Site Technology Screening

A nearshore disposal site requires a relatively large area (depending upon the quantity of sediment being disposed) with a relatively flat bottom. The disposal site should be adjacent to an upland area such that the site can be used as an extension of the upland when the sediment site is filled.

The area east of the PSR site beginning at the PSR main pier and running eastward to the second Lockheed pier would serve as a good candidate nearshore disposal site (see Figure 1). This area has a minimally sloping bottom and ranges in depth from approximately -5 to -35 feet below MLLW. A berm consisting of quarry spalls, riprap, or equivalent would need to be constructed on the north and east side of the disposal site to confine the sediments. Assuming the disposal site was filled to an elevation of approximately +10 feet above MLLW, the site could contain nearly 600,000 cubic yards of sediment. The berm would be approximately 2,000 feet long and 150 feet wide at the base. Figures 1 and 2 show a conceptual site plan and berm cross-section of the potential disposal site. Additional disposal volume could be obtained by extending the disposal site further eastward onto Lockheed property. A northward extension of the disposal site is not practical since the slopes increase more rapidly and would require an increasingly larger berm footprint.

Site characteristics in the vicinity of Lockheed would likely be conducive to including creation of intertidal or shallow nearshore benthic habitats as a component of the nearshore facilities design. Given the proximity to the mouth of the Duwamish River and the lack of intertidal habitat, this type of mitigation action would be very desirable.

Other similar nearshore disposal sites could also be constructed within Elliott Bay. Possible locations include the area at the north end of Harbor Island and Pier 91. These sites, however, are likely to be unavailable due to their use for other purposes. Nearshore disposal sites are not technically difficult to construct.

Because of the availability of potential nearshore disposal sites to the PSR MSU and the effectiveness and relative ease of construction, nearshore disposal has been retained for further evaluation.

CAD sites generally require large areas in deep water (at least 60 feet deep so as not to impede navigation) with bottom slopes of 6 percent or less. Depending upon the bottom slope, a retaining berm may need to be constructed on the downslope side of the CAD to prevent mass movement of placed sediment. Currently, no areas in Puget Sound where this type of site could be constructed have been identified. The U.S. Army Corps of Engineers is presently conducting an inventory of available nearshore and CAD sites in Puget Sound. Any sites identified as part of this inventory with sufficient capacity in the vicinity of Elliott Bay will be included in the detailed evaluation technical memorandum (No. 3).

CAD has been retained for further evaluation (assuming this type of site is available) due to its effectiveness in confining sediment and its feasibility of construction.

Upland disposal requires large areas of land where the contaminated sediment could be dewatered (if hydraulically dredged) and landfilled. Disposal alone would require an area of 11 to 22 acres for construction of a disposal cell. Sediment would either need to be pumped to this site hydraulically or be loaded off barges into trucks and shipped to the site Typically, if an upland site is used for dewatering and disposal, a site approximately 30 percent larger than that required to dispose of the sediment is needed to allow for settling. Mechanical dredging does not necessarily need this additional space since the sediment is likely to be close to *in situ* density when it is removed. However, use of mechanical dredges results in additional handling of the sediment (offloading barges, loading/offloading trucks) between the point of dredging and the point of disposal, which results in additional time, costs, and potential for exposure to workers or release back into the environment.

An established landfill could be used for disposal instead of constructing a new upland facility. In this instance, the sediment would need to be dewatered and stabilized to ensure no free water was present. This may require adding up to 10 to 50 percent stabilizing agent by volume. The stabilized sediment could then be loaded into trucks and taken to the transfer station near 4th Avenue and Lander Street where it would be loaded onto transporters for delivery to the Roosevelt Subtitle D landfill in eastern Washington. Disposal at landfill is estimated to cost roughly double the cost of nearshore disposal (i.e., $110 per cubic yard).

Upland disposal is not retained for further evaluation since no large areas of land are available for disposal site construction and trucking the sediment to an established disposal site (including disposal costs) is prohibitively expensive ($59,000,000 for 500,000 cubic yards, to $120,000,000 for 1,000,000 cubic yards).

3.2.5 Treatment Technology Screening

There are many different types of treatment processes that could be used to treat contaminated sediments. Typically, the sediment needs to have a minimum of moisture for the technology to be effective. Thermal processes require moisture contents of less than 25 percent (typical *in situ* sediment is about 50 percent water) to keep costs and treatment times to a minimum. Similar restrictions exist for the other types of treatment processes such as solvent extraction and soil washing. Therefore, dewatering cells and/or filter presses would be required for sediment pre-treatment. Sediment dewatering is most cost effective when dewatering cells are used. Mechanical methods (i.e., filter presses) are much slower and more costly.

A typical treatment process can treat sediment at rates of 5 to 30 tons per hour (one cubic yard is about 1.5 tons). Assuming sediment could be treated at the maximum capacity of 30 tons per hour, it would require approximately 4 years and 8 years to treat sediment contaminated over CSLs and SQS standards, respectively. This assumes a 24-hour, 7-day work week with the system operating at 72 percent efficiency.

Dredging can occur at rates an order of magnitude faster than treatment rates. Therefore, either a very large stockpile of dredged sediment would need to be constructed or the dredging rates would need to slowed down tremendously. Either option has significant disadvantages in terms of costs. Stockpiling sediment on-site would create a pile of contaminated material approximately 650 feet square by 30 feet high at a minimum. Dredging at a rate comparable to treatment throughput results in significant dredging costs due to standby time incurred by the dredge operator.

At a minimum, treatment costs alone are estimated at $40 million ($40 per cubic yard), exclusive of dewatering, disposal, dredging costs and transportation. Additional costs for disposal, dredging and handling could easily double this cost. Stockpiling the sediment to keep costs low would result in a large pile of contaminated material located on the upland portion of the PSR site that would be present for many years and could result in significant human health exposure concerns and shorter-term risks. Because of the length treatment periods, large costs and potential shorter-term risks, treatment has not been retained for further evaluation.

4. SUMMARY OF IDENTIFICATION AND SCREENING OF TECHNOLOGIES

Based on the evaluation above, capping to CSL and SQS criteria, removal to CSL criteria and disposal, or a combination of the above technologies have been retained for alternative development.

A summary of technology screening is provided in Table 1.

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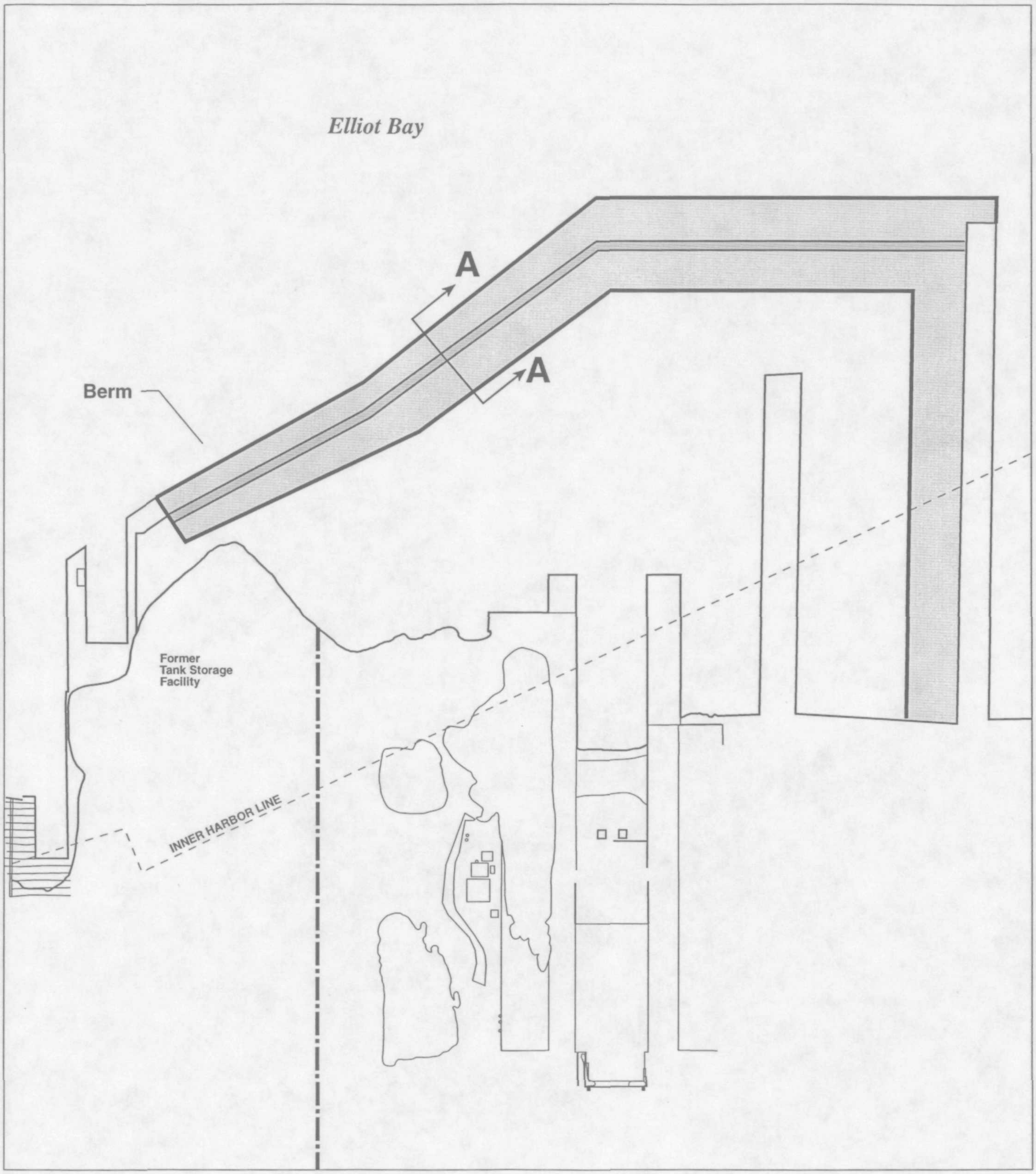
Environmental Protection Agency Region 10, Seattle, Washington. Roy F. Weston, Inc., Seattle, Washington. September.

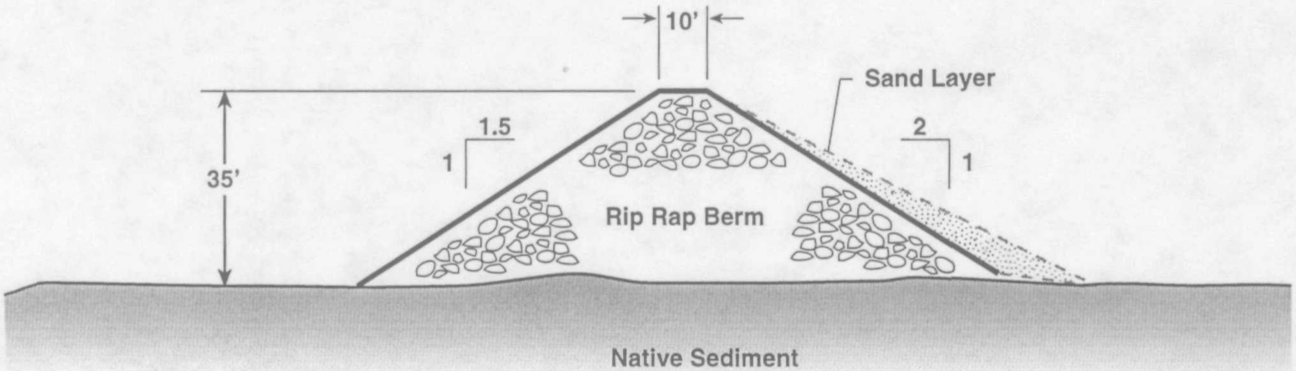


WESTON MANAGERS DESIGNERS/CONSULTANTS

PSR
Nearshore Disposal
Site Map

FIGURE
1

98-0147 Fig1.fh7



PSR – FS
Cross-Section A-A

FIGURE
2

WESTON
MANAGERS DESIGNERS/CONSULTANTS

98-0147 Fig2secA.fh7

Table 1—Technology Screening Summary

General Response Action	Technology Type	Screening Comments	Retained for Alternative Development
Containment	Sand/Silt Capping	Capping can protect the environment and human health. A cap over the contaminated sediments could be constructed without extreme difficulties. Some difficulty may be experienced in obtaining a readily available supply of clean cap material. Capping will be evaluated to achieve both SQS (~$2 million) and CSL (~$3.5 million) standards.	Yes
Removal	Hydraulic Dredging	Hydraulic dredging results in minimal resuspension of contaminated sediment. Hydraulic dredging can attain depths of 150 feet. Hydraulic dredges typically generate significant quantities of dredge water that requires handling and treatment. However, special hydraulic dredges can remove sediment at 50 to 60% solids.	Yes
		Dredging all sediments exceeding CSLs may be technically feasible. The area associated with CSL exceedances occurs at depths <200 feet MLLW and generates a volume of about 500,000 cubic yards. Cost of removal and disposal are roughly estimated at $30 million.	Yes
		Dredging all sediment exceeding SQS standards would be technically difficult due to dredge depth limitations (approximately -200 feet). In addition it would be extremely expensive (about $60 million) and no local disposal sites are available that could handle approximately 1 million cubic yards. Therefore, dredging all sediment that exceeds SQS standards is not considered further.	No
Removal	Mechanical Dredging	Mechanical dredges can attain depths of over 200 feet. Mechanical dredges remove sediment at near *in situ* densities with a minimum of entrained water. Removal rates are slower compared to hydraulic dredging. High resuspension rates may be experienced.	Yes
		Dredging all sediments exceeding CSLs may be technically feasible. The area associated with CSL exceedances occurs at depths <200 feet MLLW and generates a volume of about 500,000 cubic yards. Cost of removal and disposal are roughly estimated at $30 million.	Yes

Table 1—Technology Screening Summary

General Response Action	Technology Type	Screening Comments	Retained for Alternative Development
Removal	Mechanical Dredging	Dredging all sediment exceeding SQS standards would be technically difficult due to dredge depth limitations (about -200 feet). In addition it would be extremely expensive and no local disposal sites are available that could handle this volume of material. Therefore, dredging all sediment that exceeds SQS standards is not considered further.	No
Disposal Following Removal	Nearshore Site	A potential nearshore site could be constructed east of the PSR pier extending over to the second Lockheed pier. This site would have significant capacity (approximately 600,000 C.Y.) for disposing PSR sediments. This site is relatively deep and flat making it acceptable for nearshore sediment disposal.	Yes
	Confined Aquatic Site	This type of disposal site is effective in disposing of contaminated sediments. This type of disposal has been retained assuming sites are available.	Yes
	Upland Site	No upland sites are available. An area ranging from 11 to 22 acres in size would be needed to dispose of the sediments. This quantity of space is not readily available in the area. Disposal at an existing landfill would be prohibitively expensive ($59,000,000 to $120,000,000) and would require stabilization prior to disposal.	No
Treatment Following Removal	Thermal	Processing rates vary from 100 to 720 tons per 24 hour day. Treatment could take up to 4 years at an absolute minimum. Large upland areas would be needed for treatment process setup. Dredging costs would be prohibitively expensive unless an upland stockpile of enormous proportions was built. Costs would be high ($176,000,000 to $363,000,000), with elevated short-term risks.	No
	Soil Washing	Processing rates vary from 20 to 720 tons per 24 day. Treatment could take up to 4 years. Large upland areas would be needed for treatment process setup. Dredging costs would be prohibitively expensive unless an upland stockpile of enormous proportions was built. Costs would be high ($105,000,000 to $217,000,000), with elevated short-term risks.	No

Table 1—Technology Screening Summary

General Response Action	Technology Type	Screening Comments	Retained for Alternative Development
Treatment Following Removal	Solvent Extraction	Processing rates vary from 20 to 360 tons per 24 hour day. Treatment could take up to 8 years. Large upland areas would be needed for treatment process setup. Dredging costs would be prohibitively expensive unless an upland stockpile of enormous proportions was built. Costs would be high ($141,000,000 to $290,000,000), with elevated short-term risks.	No